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Exploring microalgae as nature's liquid tree: A needs assessment study for Davao City

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Abstract

This research study aims to assess the potential of microalgae as "nature's liquid tree" to mitigate major environmental issues in Davao City, including the urban heat caused by dense urbanization and inadequate greening initiatives. Assessing the viability of employing microalgae to lessen the urban heat island effect is the main goal. The research study investigates the knowledge and attitudes of stakeholders about microalgae, highlighting particular requirements, difficulties, and possible advantages related to their application as a natural remedy. By collecting the perspectives of stakeholders impacted by gray infrastructure and urban heat, the research study aims to draw attention to the institutional, strategic, and regulatory support required to advance microalgae projects.

Additionally, it also explores the effects of integrating microalgae in urban environments and develops policy recommendations to support microalgae as a good substitute for conventional tree planting in Davao City, where there is a limited amount of land use. By researching creative ways to improve environmental resilience in urban environments, this research supports sustainable urban development methods.

Keywords: Liquid Tree; Micro-Algae; Urban Greening; Urbanization; Urban Heat; Environmental

1 Introduction

Globally, the rising temperature due to anthropogenic actions, which resulted in climate change, gives rise to extreme weather events that greatly impact both the natural environment and the human population.

Rapid urbanization, climate change, and an increasing population pose health risks as a result of urban heat. The alarming increase in temperature poses a threat to our ecosystems and communities in every region across the globe. This enormous occurrence may eventually surpass Mother Earth's adaptive capacities to handle it if the government and individuals do not do something to solve the problem. This particular phenomenon should be addressed so that it does not worsen.

Consequently, some projects and activities for mitigating measures and strategic interventions have already been proposed and implemented by the Davao Region's key cities, municipalities, and provinces. In Davao City, numerous City Ordinances are being passed to alleviate measures and strategic interventions to address environmental and health-related issues. Davao City has passed local city ordinances on Tree Canopy, Arbor Day and Tree Planting Ordinance, Heritage Ordinance, Prohibiting Land Contour Alterations, Ecological Solid Waste Management, Health and Sanitation, Permeable Pavement, Rainwater Harvesting, Septage and Sewerage Management, Single-Use Plastics and Watershed Code, Streetscape Design Standards, among others.

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However, given the current situation in the city brought about by the El Niño phenomenon, and the implication of the mostly gray infrastructures in the central business districts, which resulted in increased urban heat island effect, it is timely that the city proposes innovative projects to fight and address urban heat issues.

The needs assessment of this research study helps address the problem and identify mitigating measures and key strategies to combat the increasing urban heat index in alignment with the Sustainable Development Goals (SDGs).

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership.

The Sustainable Development Goals (SDGs) that aligned with the environmental and health effects as a result of climate change include Goal 3: Good Health and Well-Being, Goal 6: Clean Water and Sanitation, Goal 11: Sustainable Cities and Communities, Goal 13: Climate Action, Goal 14: Life Below Water and Goal 15: Life on Land.

The above-mentioned goals and economic approaches are described in different color-coding economies: the green economy, blue economy, and golden economy. These sustainable development goals highlight the interrelation between climate change, environmental degradation, and human health, stressing the importance of cohesive approaches to address multifaceted challenges globally.

Also, a Davao City-based environmentalist from Interfacing Development Interventions for Sustainability (IDIS) through its Facebook post on April 11, 2024, advocated for crafting a local green ordinance to reduce Urban Heat Island (UHI). The Civic Society Organization (CSO), through its year-long study on UHI from April 2022 to April 2023, identified and developed mitigation strategies for the health build-up in urban areas, particularly in Davao City and Tagum City.

The needs assessment research study on the concept of microalgae as “nature’s liquid tree” explores the potential application of microalgae to offer various advantages to environmental sustainability and communities, including when cultured in urban or city areas, that can fight extreme weather events such as El Niño.

1.1 Statement of the Problem

Like most of the areas in the entire country, Davao City faced significant environmental challenges, including urban heat due to urban density and gray infrastructures, the non-strengthening of the implementation of permeable pavements, and insufficient urban greening.

There is a need to assess the potential of microalgae as liquid trees as one of the solutions to combat the rising temperature is the primary problem statement of the research proposal.

1.2 Objectives of the Study

The objectives of the study are to identify the needs assessment in the exploration of microalgae as nature’s liquid tree. Like most of the areas in the entire country, Davao City faced significant environmental challenges, including urban heat due to urban density and gray infrastructures, the non-strengthening of the implementation of permeable pavements, and insufficient urban greening.

There is a need to assess the potential of microalgae as liquid trees as one of the solutions to combat the rising temperature, which is the primary problem statement of the research proposal.

- To assess knowledge and perception of the use of microalgae as a liquid tree among various stakeholders of Davao City.
- To evaluate the specific needs, problems, and potential benefits identified by stakeholders when implementing microalgae as a liquid tree in nature-based projects as an alternative to mitigate the urban heat island effect in the urban areas of Davao City.
- To look into the experiences and lessons obtained from stakeholders who have urban heat island conditions and gray infrastructure development in Davao City.
- To learn about the viewpoints of stakeholders on the regulatory framework, strategies, and institutional support necessary to promote microalgae-based projects for reducing urban heat island effects.

- To explore the possible implications of the microalgae as a liquid tree to be built in the urban areas within Davao City.
- To explore recommendations for possible policy formulation by promoting microalgae as a liquid tree as a possible alternative replacement for planting trees within Davao City's urban areas, due to the unavailability of land as a result of gray infrastructure, particularly in the central business districts.

1.3 Scope and Limitations of the Study

The scope of the study will focus on the central business districts of Davao City, where gray infrastructures are situated. “Gray infrastructure" refers to traditional, man-made structures such as buildings, roads, bridges, and other physical infrastructure typically constructed using concrete, steel, or other materials. These structures are often designed to provide essential services such as transportation, shelter, and utilities to support human activities and urban development.

The limitation of this needs assessment study is the limited availability of data since this study is only exploring insights of the target participants by identifying the needs assessment of the microalgae as a liquid tree. In some areas of the study, data may be incomplete due to some constraints and no available data in the library, which could affect the process of the research study and the comprehensiveness of the data.

Despite limitations, the research study aims to provide an understanding and perceptions of the needs assessment of the microalgae as a liquid tree and its potential benefits for the sustainability of the microalgae as a substitution for a natural tree in urban settings where trees cannot grow exponentially due to established gray infrastructures that are already built within the central business districts of Davao City.

1.4 Significance of the Study

The significance of the study of this qualitative research proposal lies in the effectiveness of identifying the needs assessment, addressing the persistent environmental challenges like climate change resulting from the urban heat island effect, while supporting sustainable urban development in Davao City. The needs assessment that can be identified through this study can help address and mitigate environmental challenges such as carbon dioxide sequestration and oxygen production.

- The needs assessment can identify opportunities to mitigate environmental challenges by exploring the potential benefits of microalgae to address and possibly reduce the urban heat island effect that Davao City currently experiences.
- The needs assessment of this study can also support economic development by providing opportunities for investments, innovation, and livelihood, contributing to economic growth within Davao City and the whole region if proposed and implemented.
- The result of the needs assessment study can provide ideas and suggestions to policy-makers, planners, and researchers to integrate microalgae-based solutions into regional development strategies, climate change initiatives, and environmental management plans and programs.

2 Review of Related Literature

2.1 Introduction to Microalgae

Microalgae are marine or freshwater microorganisms consisting of a single eukaryotic cell. These are unicellular flora representatives with huge potential for application in various branches of science and technology [1]. Microalgae biomass production technologies do not pollute the environment, use carbon dioxide while generating oxygen, consume a relatively small amount of water, and may occupy land unsuitable for the cultivation of agricultural crops [2].

Microalgae (photosynthetic microorganisms) that are found all over the world high in fresh, seawater and soil habitats are known to have many uses (Ghasemi, Moradian, Mohagheghzadeh, Shokravi, & Morowvat, 2007).

Microalgae are a group of autotrophic microorganisms that live in marine, freshwater, and soil ecosystems and produce organic substances in the process of photosynthesis (Dolganyuk, et al 2020).

2.2 Environmental Benefits of Microalgae

According to the report of the United Nations Development Program (UNDP), in its article “The First Algae air purifier in Serbia, dated September 21, 2021, the Microalgae as Liquid Tree as the first urban photo-bioreactor in Serbia, "LIQUID 3", has been placed in front of the Municipality of Stari Grad in Makedonska Street in Belgrade. This "liquid tree", as it is called at the “Institute for Multidisciplinary Research” of the University of Belgrade, where it was designed, is a completely new biotechnological solution for air purification and reduction of carbon dioxide (CO2) emissions in urban areas where its concentrations are highest.

“The photobioreactor is a completely new biotechnological solution for air purification and the production of oxygen. In an aquarium of six hundred liters of water, have algae that bind carbon dioxide and produce pure oxygen through photosynthesis. The project is designed to be multifunctional. LIQUID3 is also a bench; it has chargers for mobile phones, as well as a solar panel, thanks to which the bench has lighting during the night.

“The microalgae in 'LIQUID 3" replace two 10-year-old trees or 200 square meters of lawn. The system is the same because both trees and grass perform photosynthesis and bind carbon dioxide. the goal is not to replace forests but to use this system to fill those urban pockets where there is no space for planting trees.

In certain conditions of great pollution, trees cannot survive, while algae do not mind that pollution”, pointed out Dr. Ivan Spasojevic, one of the authors of the project from the Institute for Multidisciplinary Research.

2.3 Microalgae as a Sustainable Resource

Examination of microalgae's potential as a renewable and sustainable resource. Review of microalgae-based products and technologies, including biofuels, bioplastics, and nutraceuticals.

2.4 Microalgae Cultivation and Biorefinery Systems

Overview of microalgae cultivation methods, including open ponds, photobioreactors, and closed systems.

2.5 Future Strategies

Liquid tree is a very innovative approach for combating air pollution by reducing carbon emissions and improving air quality. In India, due to rapid urbanization, the greenery is declining day by day, which has a significant effect on the environment and public health. This liquid may prove to be an effective solution for India, as 22 out of the 30 most polluted cities in the World fall in India (Saxena, 2023).

By adopting this technology, India may improve the quality of life of its citizens and make cities more livable. The liquid tree with the potential to sequester carbon dioxide, release pure oxygen, and purify the atmosphere represents a promising solution that marries nature and technology (Dhar, Dey, Sarkar, 2023).

3 Methodology

3.1 Research Design

Description of the research design, including the overall approach, methods, and techniques employed in the study. Justification for the chosen research design is based on the research objectives and scope.

3.2 Data Collection

The data collection methods and instruments used in the study include such as literature review, surveys, interviews, and site visits. Discussion on the sampling strategy, sample size determination, and data collection procedures.

3.3 Data Analysis

Overview of the data analysis techniques and tools applied to analyze the collected data. Explanation of how the data analysis process aligns with the research objectives and aims to address the research problem.

3.4 Significance of the Study

The significance of this qualitative research proposal lies in the effectiveness of identifying the needs assessment that can help address persistent environmental challenges like climate change resulting from urban heat, while supporting sustainable urban development in Davao City. The needs assessment identified through this study can help address and mitigate environmental challenges such as carbon dioxide sequestration and oxygen production.

3.5 Conceptual Framework

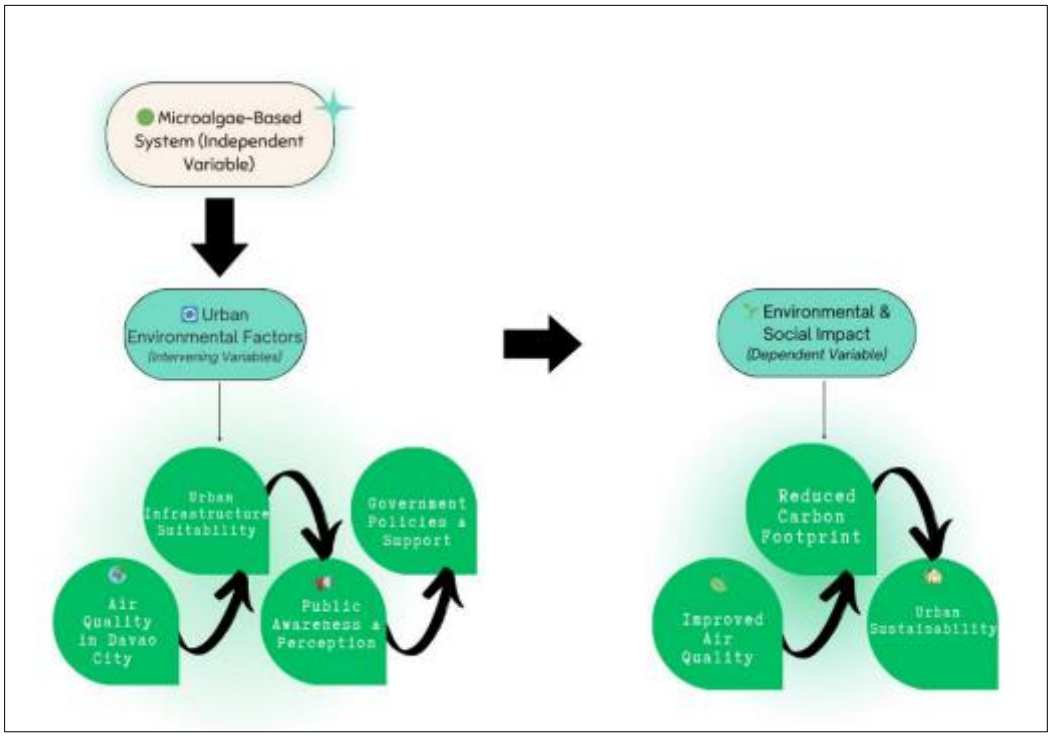

Figure 1 Conceptual Framework showing Independent Variable and Dependent Variable

This conceptual framework depicts the interaction between a microalgae-based system and its potential environmental and social impact, with urban environmental factors serving as mediators.

3.6 Microalgae-Based System (Independent Variable)

Microalgae, like a "liquid tree," can absorb CO_2 and produce O_2 to purify the air naturally.

4 Urban Environmental Factors (Intervening Variables)

4.1 Air Quality in Davao City

The pollution levels will determine the necessity and efficacy of microalgae systems.

4.2 Urban Infrastructure Suitability

It is the ability to incorporate microalgae systems into public places or structures.

4.3 Public Awareness and Perception

The community's comprehension and acceptance of microalgae technology. Government policies and support provide regulatory and financial support for long-term solutions.

4.4 Government Policies & Support

Government regulatory and financial support are backing sustainable solutions.

4.5 Environmental and Social Impact (Dependent Variable)

Biofiltration reduces air contaminants, resulting in improved air quality.

4.6 Environmental Impact Assessment

The needs assessment of microalgae cultivation as nature's liquid tree in Davao City and its viability for carbon sequestration, which can contribute to improving air quality and climate change mitigation.

The liquid tree technology, if implemented, could be used as a natural air purifier and could mitigate air pollution in the streets of Davao City, where most of the structural buildings are gray infrastructures. The liquid tree can uptake carbon dioxide more resourcefully and entails less maintenance and less space requirement.

5 Conclusion

The significance of microalgae in improving environmental resilience in urban settings is highlighted by this study. It seeks to promote institutional and strategic encouragement for microalgae initiatives by addressing information gaps and stakeholder perceptions, ultimately assisting Davao City's sustainable urban development. The results support creative approaches to environmental problems and establish microalgae as a viable substitute for urban greening in densely populated cities.

6 Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed in the conduct of this needs assessment study on the potential of microalgae as "nature's liquid tree" in Davao City.

Statement of ethical approval

The study assesses the environmental impacts of microalgae integration while adhering to local rules and regulations or local city ordinances and promoting transparency throughout the research process.

The study does not involve any studies performed on animals or any human subjects by any of the authors.

Statement of informed consent

The researcher ensured informed consent was obtained from all stakeholders and other individuals included in the study to address their concerns and perspectives.

The authors are dedicated to promoting inclusion and community involvement, making sure that a range of viewpoints are reflected in our conclusions and suggested policies. This ethical approval demonstrates our commitment to carrying out research that promotes environmental resilience and sustainable urban development in Davao City.

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